

Institute for Physical Research and Technology

ANNUAL REPORT 2000

IPRT WORKS for Iowa



Economic Development

Tracking Down Fugitive Emissions

Research

Cleaner Air, Cleaner Water

Education

Science Bound Reaches New Heights

IOWA STATE UNIVERSITY

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Airworthiness Assurance Center of Excellence

Ames Laboratory of the U.S. Department of Energy

Center for Advanced Technology Development

Center for Nondestructive Evaluation

Center for Physical and Computational Mathematics

Center for Sustainable Environmental Technologies

International Institute of Theoretical

and Applied Physics

Materials Preparation Center

Microanalytical Instrumentation Center

Microelectronics Research Center

Virtual Reality Applications Center

Industrial Outreach Programs

Iowa Companies Assistance Program

Iowa Demonstration Laboratory

Iowa Industrial Incentive Program

Cover: Fisher Controls International, Inc. is one of the world’s leading suppliers of valves, regulators and services to the process-control industries. The Marshalltown company has teamed with researchers from the Microanalytical Instrumentation Center to invent a new instrument that sniffs out unwanted emissions in oil refineries, chemical plants and the like. (Image courtesy of Fisher Controls International, Inc.)

DIRECTOR'S LETTER

Working for Iowa



Working for Iowa is our mission here at Iowa State University's Institute for Physical Research and Technology. We take that charge seriously, as illustrated by our efforts in three primary areas:

- **Economic development.** Through its centers and outreach programs, IPRT assists hundreds of Iowa companies each year, solving problems that save money, improve quality and expand markets. We also help launch start-up companies, helping cross the chasm between research and commercialization.
- **Research.** Our unique relationship to ISU and to industry provides the ideal crucible for research to thrive. Our centers — and our researchers — are world-leaders in their fields.
- **Science and technology education.** IPRT is a unique educational resource for Iowa, helping to improve the technical knowledge and skills of tomorrow's workforce. IPRT gives ISU students opportunities to work on actual technical problems encountered by today's companies.

The articles in this annual report provide examples and news of IPRT's efforts in each of these areas. As you read through them, you might also note a couple of important common threads.

First, economic development, research and education are not isolated, independent efforts but instead are interrelated, complementary goals. Most IPRT projects involve aspects of all of these three areas and are carried out by interdisciplinary teams.

Second, many of our projects make Iowa — and the world — safer and cleaner and its people healthier. Our lead-free solder eliminates toxins from products and landfills. A forensic initiative promises to put high technology to work solving crimes. Catalyst research allows chemical reactions and syntheses without production of harmful waste. And those are just a few examples.

Lastly, the relationships we form with Iowa companies often continue for years. Rather than just coming to us for assistance with a single problem, many Iowa companies look to IPRT as a touchstone to keep them on the leading edge of various technologies.

IPRT's intellectual capital — made up of some 760 faculty, staff and students — works to make Iowa a better place to live and do business. If we can serve you, give us a call.

IPRT Director

HIGH-RETURN ECONOMIC DEVELOPMENT



John Dilger is a researchers with Fisher Controls International, Inc. in Marshalltown, Iowa. He's part of a team from Fisher and the Microanalytical Instrumentation Center that's developing a novel emission sensor for process plants such as oil refineries. This project is one example of how IPRT fosters economic development with Iowa industry, either through its research centers or through three dedicated outreach programs.

Tracking Down Fugitive Emissions

The Microanalytical Instrumentation Center and Fisher Controls collaborate to invent a new instrument to sniff out “fugitive” emissions.

A team of researchers from Fisher Controls International, Inc. and IPRT’s Microanalytical Instrumentation Center are out to catch a fugitive. But it’s not a person they’re after. Instead, the team is working on an instrument to sense unwanted emissions of volatile organic compounds from valves, pumps and flanges in chemical plants, oil refineries and the like.

Fisher, based in Marshalltown, Iowa, is one of the world’s leading suppliers of valves, regulators and services to the process-control industries. A few years ago, Fisher noticed its customers were spending a great deal of time, labor and money meeting regulations for monitoring leaks, or “fugitive emissions,” as they are known. “These plants can have literally tens of thousands of leak points to measure,” said John Dilger, a senior research specialist with Fisher. Today, maintenance personnel use hand-held instruments to check for leaks. These practices are dictated by the Environmental Protection Agency, and some plants are required to conduct a survey as often as every month.

Fisher sought a more automated way to detect these emissions and assist its customers in complying with EPA regulations. The company knew it would need help as the required technology was well removed from its existing expertise. Fisher found that assistance at the MIC, whose expertise lies in the creation of



Researcher John Dilger of Fisher Controls examines the sensors in a new instrument designed to detect unwanted emissions in process plants.

miniaturized instrumentation for chemical analysis in alien and hostile environments.

“The nice part of the relationship was that the folks at MIC had the ability to take this analytical tool and teach us how it might be employed in the field,” said Dilger. For its part, Fisher brought experience at building industrial instrumentation. “It was a good marriage between the two organizations,” Dilger said.

Ruth Shinar, principal investigator at the MIC, who has been with the project since its inception in 1995, agrees. “It’s really been a team effort.” Other Fisher people involved in the effort include Meredith

Miller, Ted Grabau and Guojun Liu. Other MIC scientists who worked on the project include Robert Lipert, Bikas Vaidya and Marc Porter, MIC director.

Together, the team created a Fugitive Emission Sensor, or FES, that will monitor fugitive emissions in process plants. The instrument, about the size of a large grapefruit, can be coupled with a valve or sit next to pumps or flanges to detect emissions.

The heart of the instrument, explained Shinar, is a gas sensor array. Here, quartz crystal microbalances sense volatile organic compounds. Their performance is determined in large part by sensi-

tive coatings applied to their surface.

The MIC team focused on designing novel coatings for this project. “They continually improved the performance and reliability of the sensors,” said Dilger. In fact, patents have been applied for some of the coatings developed for this project.

Other parts of the system include an array for measuring temperature and relative humidity, a delivery system for bringing gas in and out of the system, and electronic communications and control.

The real key is the instrument’s ability to operate in harsh plant environments. “That’s one of the things that makes it unique,” said Dilger. It will operate in environments from minus 10 C to 50 C and high relative humidity; it can withstand vibration, dust and oxidation. What’s more, the device has low power consumption, a critical factor in any plant instrumentation.

The FES has undergone extensive field-testing. If all goes as planned, Dilger said he expects the instrument will become a successful commercial product for Fisher Controls. Although it will not completely replace the current process mandated by the EPA, it will provide early warning of fugitive emissions and will allow plant operators to run cleaner plants, according to Dilger. ■

Proving an Innovation

IPRT helps two Iowa companies expand the market for environmentally friendly lead-free solder.

John Josephson believes. So does Alan Gickler. Now, they're on a mission to bring others around to their way of thinking.

As president of a Ft. Dodge, Iowa, maker of copper-brass radiators that bears his name — Josephson Manufacturing — Josephson is convinced that lead-free solder is the wave of the future. Gickler, president of Johnson Manufacturing, a Princeton, Iowa-based producer of lead-free solder, agrees; in fact, Johnson has become a leading supplier of the product to Josephson and other manufacturers.

Solder is widely used in manufacturing to bond metals at low-temperature. Tin-lead solder has been the traditional alloy of choice for these applications. But, recently-developed lead-free versions result in safer workplaces and a cleaner environment, with the added benefit of creating stronger joints.

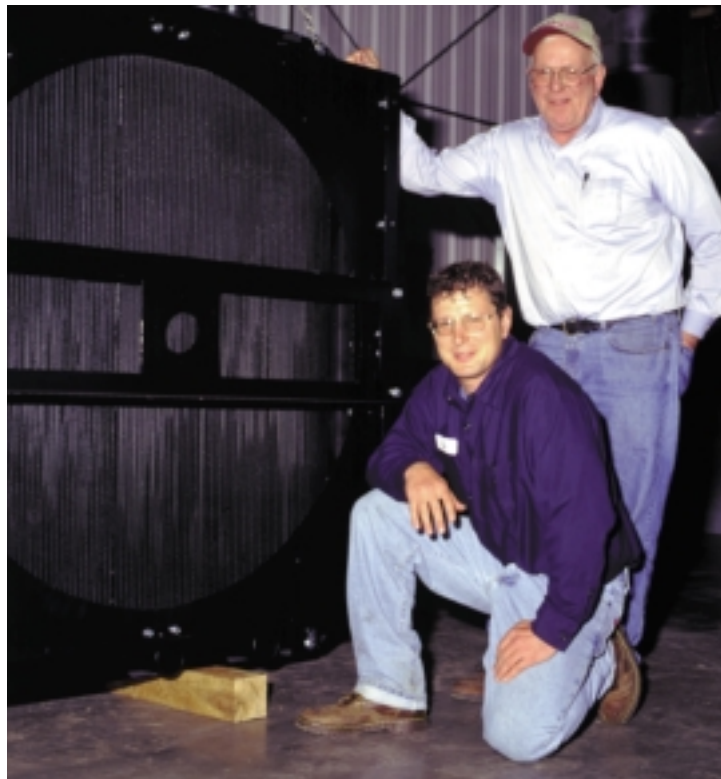
"The three main issues that drive our use of lead-free solder are the health of our people, the environment and better product for our customers," said Josephson.

Trouble is, not all of Josephson's and Gickler's customers share their belief in lead-free solder. Although manufacturers around the globe are striving to eliminate lead solder from their products, they need assurances that products made with it will perform as desired.

In particular, Josephson had to prove to one of his customers — the world's largest off-highway equipment manufacturer — that radiators made with lead-free solder have the strength and fatigue resistance required to withstand high temperatures and severe vibrations.

That's not an easy task. For starters, there isn't just one lead-free alloy that can handle all applications, according to Gickler. Indeed, dozens of lead-free solders are available, and each has its advantages for particular applications in terms of strength, workability, melting temperature and compatibility. Acquiring the necessary data would require a battery of tests.

Both Josephson and Gickler knew where to go to get help: IPRT's Ames Laboratory. Through its work on developing lead-free alloys and its general materials expertise, the Ames Lab was uniquely qualified to do the research. Josephson and Gickler contacted Ames Lab's James Foley, an associate scientist.



John (standing) and Erik Josephson of Josephson Manufacturing display a copper-brass radiator their company built for heavy equipment. The company uses lead-free solder made by Johnson Manufacturing in its products.

Through an IPRT outreach effort called the Iowa Companies Assistance Program, Foley arranged for 80 hours (40 hours for each company) of no-cost technical assistance.

IPRT's Center for Advanced Technology Development, through matching funds from Johnson, covered the cost of test samples and machining. In addition to Foley, Gickler and Josephson, the research team included Larry LePrevost, executive vice president, and David Brown, chief engineer, both of Johnson Manufacturing.

The team set up a study to compare the strength of various lead-free solders with lead-containing solders. In the end, it ran more than 400 tests to cover all the variables on some 15 different solder alloys for possible use in radiators. Test results showed that all of the selected lead-free alloys had shear strengths greater than alloys containing lead.

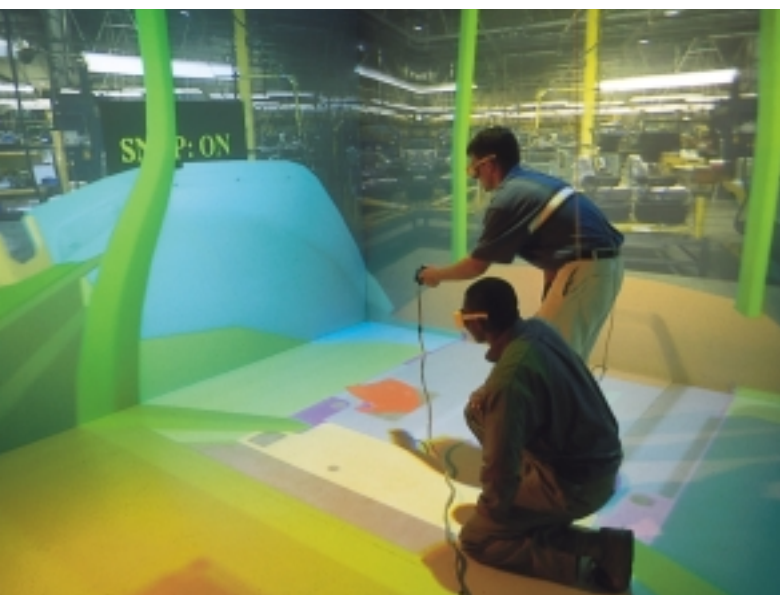
"We have a pretty strong feeling that some of the alloys we studied in this project will be those used worldwide in the heat-exchanger industry," Gickler said. He added that Johnson will use the results to educate its customers about lead-free solder.

Josephson is "extremely pleased" with the study. "It validates our thinking and validates what we've talked to our customers about in terms of strength," he said. Josephson's company began courting that off-highway equipment manufacturer some two years ago. The company is putting finishing touches on a prototype radiator made with lead-free solder, which will likely lead to production units in the near future. ■

Building Virtual Products

Deere & Company finds world-class virtual reality technology in its own backyard at the Virtual Reality Applications Center.

Simply put, virtual reality is an amazing technology. Through the use of computer-generated images and sound, VR creates synthetic environments that can be experienced as “real” to users.



Researchers examine a virtual assembly operation inside the new C6 virtual reality theater at the Virtual Reality Applications Center.

While VR has become popular because of its use in movies and entertainment, the technology can greatly benefit industry users as well. In fact, Deere & Company, one of Iowa's largest employers, has become a leading user of VR. “The advantages of virtual reality, or what we like to call virtual prototyping, in the Deere organization are centered around product development,” said Jerry Duncan, senior staff engineer and a leading propo-

nent of VR at Deere. The company looks to VR to foster innovation and create better solutions in less time.

To speed its development and understanding of VR, Deere has come to rely on IPRT's Virtual Reality Applications Center. VRAC is focused on the application of VR to problems in engineering and science and is home to some of the most advanced VR facilities in the world.

Although the relationship between Deere and VRAC began as a single research project in 1994, the two organizations are now in the midst of a three-year effort with multiple projects. The early research helped convince Deere that VR was a viable technology, explained Judy Vance, a VRAC researcher and associate professor of mechanical engineering at Iowa State University. Current projects are now aimed at developing tools Deere can use throughout its organization. Indeed, all Deere units are now involved in this virtual prototyping research activity, according to Duncan.

VRAC's current research with Deere involves five ISU faculty members and more than 10 students. Projects include vehicle simulation, studies of human factors and ergonomics, engineering data analysis, virtual assembly methods planning, and collaborative engineering. But, “the potential for using VR goes well beyond product design,” said Duncan.

Indeed, the real advantage of virtual reality may be in its ability to help people collaborate over long distances. “Deere is a global company and has many divisions,” said Duncan. “The virtual reality technology

allows us to immerse people from various disciplines, not just engineering, but managers, marketing people, customers. All these people can come together in the same virtual environment to experience different design concepts.”

These projects all tap VRAC's advanced VR facilities, which include the new C6 virtual reality theater, one of only a handful of systems in the world that projects images on all six sides of a room — four walls, ceiling and floor. The C6 is also the first VR system that provides wireless interaction devices in this type of virtual reality environment for users, leaving the space inside C6 clear of anything that detracts from total immersion. Deere also made a substantial contribution to construction of the C6 beyond its other research projects.

VRAC is also ideally suited to study virtual collaboration. Its two VR theaters, located a block apart, are linked via fiber optic cable so users in both facilities can share a common environment. What's more, a new auditorium on the ISU campus can display stereo 3D images from both virtual reality environments simultaneously, allowing up to 250 people to share the experience.

Research is not all that Deere gets from VRAC. Vance said three VRAC students have gone on to work for Deere in Iowa, and several other VRAC students have participated in Deere internships. “Part of the way for Deere to get this technology into its business is to hire experts, and we are educating experts,” said Vance. “We're already talking about follow-on projects. It looks like it's going to be a continuing relationship.” ■

Testing Insight

Scientists at the Iowa Demonstration Laboratory apply ultrasonic testing to help an electrical components manufacturer improve its products.

How do you peer inside a brazed joint to evaluate its quality? That was the problem faced by Jon Oswood, chief metallurgist at Square D, during the development of a new circuit breaker. He solved it with help from IPRT's Iowa Demonstration Laboratory, an outreach program of the Center for Nondestructive Evaluation.

Square D's business is to put electricity to work. Its products are found in all types of residential, commercial and industrial applications. The company, a division of Schneider Electric, has over 900 employees in Cedar Rapids, where it manufactures large circuit breakers, among other products. This site is also the North American design center for circuit breakers within Schneider.

Circuit breakers are critical devices in electrical systems, serving to stop the current if it becomes too high. Inside a circuit breaker, a pair of contacts is forced apart when the breaker is tripped, cutting off current. These contacts are made of silver, tungsten and sometimes other materials so they both conduct electricity and withstand eroding caused by electrical arcing that occurs when the breaker is tripped.

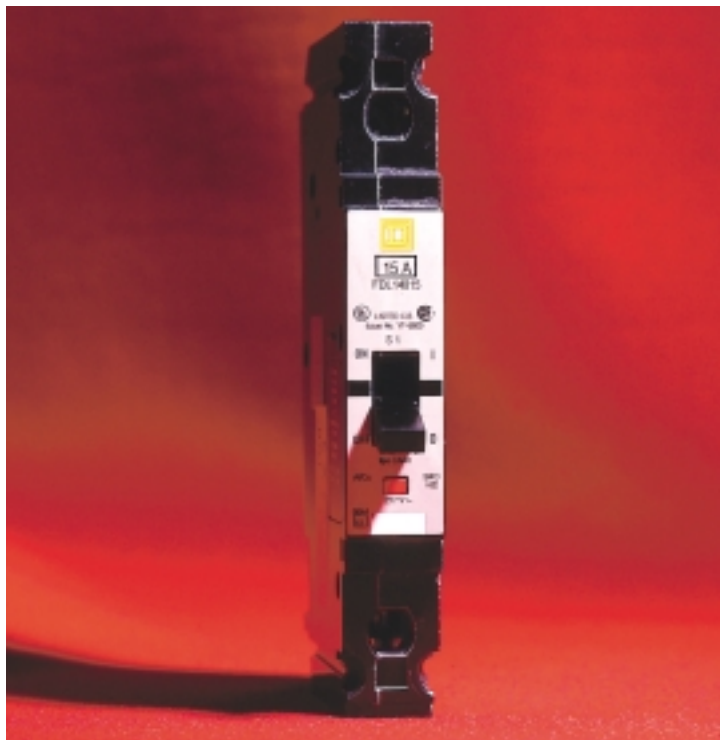
These contacts, in turn, are brazed to copper current-carrying components. It was in these critical junctures, called attachments, that Oswood turned to IDL and CNDE for help in evaluating. While the center is expert in numerous methods of nondestructive evaluation, scientist Dave Utrata knew that ultrasound — similar to that used in the medical field — could provide the information that Oswood needed.

"When we use ultrasound, we send high-frequency sound waves into a part and look for reflections," explained Utrata. "A well-brazed joint is actually quite transparent to ultrasound, so it gives back very little signal. If it's poorly brazed, it will give us quite a strong reflection."

The testing confirmed that the attachment integrity has an effect on contact performance. "We demonstrated that ultrasonic inspection could be used to characterize the bond at these brazed joints," said Utrata. As a result, Oswood said that Square D has developed technologies to enhance the attachments — and thus the performance — in several new products. The improved attachments should also help the product more easily pass required UL testing.

Square D has worked with IDL for some six years on various projects. "We don't have ultrasonic testing equipment available to us in Cedar Rapids," said Oswood.

Although ultrasonic testing has many possible applications in industry, most manufacturers are not familiar enough with the technology to use it on a regular basis, according to Utrata. For Iowa companies, IDL can help introduce them to the technology, develop techniques and provide information. Some companies, such as Square D, go beyond this initial stage and contract with CNDE to do further work, Utrata explained. ■



Square D received assistance from the Iowa Demonstration Laboratory to improve brazed joints in its circuit breakers.

Sticking with Soybeans

A start-up Iowa company with plans to manufacture soy-based adhesives gets assistance from the Center for Advanced Technology Development.



The father-son team of Frank M. Trocino (left) and Frank S. Trocino are coming to Iowa to start a new company, Heartland Resource Technologies, to manufacture adhesives made primarily from soybeans.

To Frank S. Trocino, it's about helping the Iowa town in which he grew up and where his 100-year-old mother still lives. To his son, Frank M. Trocino, it's about a new opportunity and doing something different. To Deland Myers, it's about using soybeans and helping farmers. To Carey Novak, it's all in a day's work.

"It" is an effort to launch a new company and build a new plant to manufacture soy-based adhesives. The company, Heartland Resource Technologies LLC of Oelwein, Iowa was founded by the Trocinos and hopes to have its plant up and running by spring 2002. Frank S. Trocino of Bellingham, Wash., is a chemical engineer and entrepreneur who plans to

bring economic development to his hometown of Oelwein. Frank M. Trocino has sold his successful architectural practice in Pasadena, Calif., to help start and run Heartland.

Myers is a professor of food science & human nutrition at Iowa State University and a member of ISU's BioComposite Research Group, whose mission is to discover value-added uses for crops to improve farmers' income. Novak is a technology transfer associate at IPRT's Center for Advanced Technology Development and an integral part of the Heartland story.

The potential for Heartland's adhesives is huge; the annual North American market for adhesives used in wood-based

panels (plywood, particleboard and the like) is approximately \$2 billion. Today, most of these resins are made from petroleum, but soybean-based adhesives may be ready to compete. The availability and pricing of most petroleum-based adhesives are subject to the vagaries of the petroleum market. Not so with those made with soybeans, a low-cost, renewable resource produced locally. (Nearly one-fifth of the U.S. soybean crop in 1999 was raised in Iowa, according to a study commissioned by the Iowa Soybean Promotion Board.)

What's more, today's soybean-based adhesives are much improved. Myers and his researchers have found ways to make adhesives from soybeans that have the strength, moisture-resistance, cure times and cost to compete with petroleum-based adhesives. "What we have to do now is find specific niches for soy-based adhesives," said Novak.

Frank M. Trocino said that CATD's and Novak's help has been instrumental, providing assistance with research agreements and market research. "If you don't have a product people want, forget it. He understands that," said Trocino. IPRT's Iowa Industrial Incentive Program also contributed \$25,000 to assist in the research effort.

Heartland is now raising nearly \$8.5 million needed to build its plant and start the company, part of which has been provided by the Iowa Department of Economic Development, the Iowa Soybean Promotion Board and U.S. Department of Agriculture. In its first year of operation, the company projects that its plant will produce 12 million pounds of adhesive and will use over 4,000 tons of soybean meal purchased in the Oelwein area. The hope is that by its fifth year, Heartland will employ 18 or so people in its highly automated facility.

Myers is impressed by the Trocinos' efforts. "We've had other companies talk to us about this technology, but they are the ones who have really sat down and analyzed the potential and see that there really is one," he said. The hope, explained Myers, is that this effort will ultimately help farmers and rural development in Iowa.

Through ISU, CATD and the Iowa Soybean Promotion Board, Myers' group is working with Heartland to develop adhesives that will be commercialized by the company. The group is testing new formulations of resins as well as fabricating and testing board products. In fact, both ISU and Heartland have patents pending on various soy-based resins. The company is banking that these formulations — actually a mixture of soy and petroleum-based adhesives — will have the right combination of features and price to find a niche in the highly competitive adhesives market. ■

An Energetic Partnership

The Microelectronics Research Center continues its relationship with a successful Iowa manufacturer of solar cells.

The founders of Iowa Thin Film Technologies, Inc. are nothing if not persistent. Frank Jeffrey and Derrick Grimmer have been researching solar energy since the 1970s. In 1985, the two physicists came together at 3M, where they worked on solar cells, which turn light energy from the sun or other sources into electricity. In 1988, they founded ITFT, which has gone on to mass produce thin-film solar cells used to generate electricity.

Today, Jeffrey's and Grimmer's company is the world's only manufacturer of thin-film, amorphous silicon solar cells on flexible polyamide film. The company employs 27 people in its Boone facility and is in the midst of a major expansion to meet the rapidly increasing demand for its unique product.

Indeed, ITFT's lightweight and flexible cells show up in an ever-widening range of places, from consumer electronics to spacecraft to buildings. Its products are even used in the popular Freeplay radios, which run on power from solar cells, a battery, or a built-in, crank-powered generator. Perhaps the brightest spot in ITFT's future, however, is an application known as Building Integrated Photovoltaics (BIPV). Here, solar cells are incorporated into standard building components such as steel roofing panels and curtain walls, to supply electricity for everyday use.

IPRT has been assisting the company all the way, even before ITFT was officially founded. IPRT's Microelectronics Research Center helped get it rolling and worked with the company to build its pilot facility in 1989. Over the years, ITFT and MRC scientists have collaborated on a number of projects. Researchers from IPRT's Ames Laboratory have also assisted the company; in fact, Jeffrey was once a grad student at the Lab.

The research has been critical because mass production of thin-film, amorphous silicon solar cells on flexible film is not trivial. In fact, before ITFT devised a way to do it, such solar cells had only been produced in small quantities in the lab, according to Grimmer. "Our business is manufacturing," he said, adding that he looks to IPRT for assistance in basic research.

ITFT's manufacturing process uses a roll-to-roll operation, where 2,400 ft.-long rolls of plastic film are fed through each process from one spool to another. These rolls undergo numerous processing steps, including deposition of various thin films, scribing by lasers, and printing with inks. Some of the deposition takes place in a vacuum, requiring specially built chambers



Steve Martens, vice president of Iowa Thin Film Technologies, shows off one of his company's latest creations: a new deposition chamber that plays a critical role in production of thin-film solar cells.

the size of small rooms. The deposition process must be carefully calibrated to ensure that the cells will work. ITFT has even designed most of its own machinery for vacuum deposition, lamination, testing and other steps in the process.

ITFT is not resting on its laurels, however. The company is working to maintain its lead in the solar-cell market by further lowering production costs and introducing new technology. IPRT's MRC is helping on both fronts:

- ITFT has a good grasp on the parameters needed to manufacture quality solar cells. Yet, like in any type of manufacturing, there is room for improvement. Scientists at MRC are working on technology to monitor the deposition process and adjust it as the cells are made. This approach

could result in increased yields, which in turn mean lower-cost solar cells.

- Vikram Dalal, MRC director, has developed a way to deposit polycrystalline silicon on the same kind of plastic substrate used in ITFT's amorphous silicon solar cells. Polycrystalline silicon solar cells are more efficient than amorphous versions. ITFT would like to adapt this technology to its mass-production methods.

These projects are only two of the latest in the ongoing connection between ITFT and IPRT. "We anticipate the relationship to continue indefinitely," said Grimmer. "It's good for Iowa business." IPRT scientists are optimistic about the company's prospects. "I think it's on the verge of really doing something, especially with the current energy situation," said Howard Shanks, MRC associate director. ■

Casting a *Solution*

Scientists from the Iowa Companies Assistance Program help an Iowa producer of die castings return to full productivity.

Kiowa Corp. of Marshalltown has a proud heritage. The Iowa company was founded in 1927 and today supplies die castings and finished parts for a range of products, including automobiles, farm and construction equipment, and computer peripherals.

"Quality is extremely important to us," said John Balong, project manager at the company. It's no surprise, then, when the company experienced a failure in one of its parts, it jumped into action. Working with IPRT's Iowa Companies Assistance Program, Kiowa tracked down the culprit and returned to full productivity.

The part in question was an aluminum cast, Y-shaped fork used in automobile transmissions. Kiowa makes these parts and ships them to its customer in Mexico. The company makes hundreds of thousands of these parts annually, so time was of the essence in finding a solution.

Kiowa first learned of the problem from its customer, who reported a failure of the fork in the field. The customer had a metallurgist examine the broken parts and report his findings to Kiowa, basically concluding that the problem was in the part's "microstructure." The microstructure of a metal part is seen with a microscope; in the case of aluminum castings, it looks like trees in a forest. These formations result when molten metal solidifies.

But that information caused some head scratching at Kiowa. "We don't have that sort of capability here, so we went looking for someone who was more knowledgeable in metallurgy," Balong said. Balong first contacted John Van Engelenhoven, the Marshalltown area representative for Iowa State University's Center for Industrial Research and Service. Engelenhoven, in turn, knew right where to go to get help: ICAP, which specializes in solving materials problems.

ICAP's Paul Berge, a metallurgist, got right on the case. Like any good detective, Berge laid out what was known. First, there was the metallurgical report and its indication of a microstructure problem. Second, it was known that the failed parts all came from the same cavity in a "spray," where four parts were made at a time, each with their own cavity.



A machine operator pours molten aluminum into a die casting mold at the Kiowa Corp. The company sought assistance from IPRT to solve a problem in one of its die cast parts.

Berge decided to have a look at the parts himself. He examined fractured forks using Scanning Electron Microscopy, a tool not normally part of a company's arsenal of equipment. He also broke two new forks in a similar fashion to the failed parts and examined them, but could not detect any difference in microstructures between failed parts and good ones. "The microstructure was not necessarily the root cause of the problem," Berge said.

Then came a break in the case. Berge looked at the die casting spray as a whole and noticed that forks made in one particular cavity had scuffed surfaces in the area where the failures occurred. What's more, all of the forks from this cavity had the same appearance.

"At this point, a light went on," Berge said. He concluded that a defect in the mold was damaging forks made in the one cavity. He shared his findings with Balong, who confirmed that indeed, there was a problem with the mold and had it fixed.

"The benefit to us was reduced scrap," Balong said, noting that the company could not ship any castings from that one cavity until the problem was fixed. Balong said he appreciated the practical advice provided by Berge. "That's really what we needed," he said. "There were excellent communications back and forth, and that really helped us solve the problem." The whole project took less than two months.

This project is all in a day's work for ICAP, where engineers such as Berge, program director Thomas Lograsso and ISU faculty team together to assist Iowa companies. With information gained by ICAP's experts, companies can improve production processes or resolve product concerns with third-party manufacturers. Since its inception, ICAP has worked on some 700 projects across the state of Iowa. ■

WORLD-CLASS RESEARCH



*M*aohong Fan is a visiting scientist from China, working with the Center for Sustainable Environmental Technologies. He's developing technology to convert byproduct sulfur from coal plants into a chemical that can purify drinking water in municipal water plants. The effort is yet another example of IPRT's world-class research and the top talent it attracts.

Cleaner Air,

The Center for Sustainable Environmental Technologies reaches around the world to bring home a technology that may lead to a better environment.

R

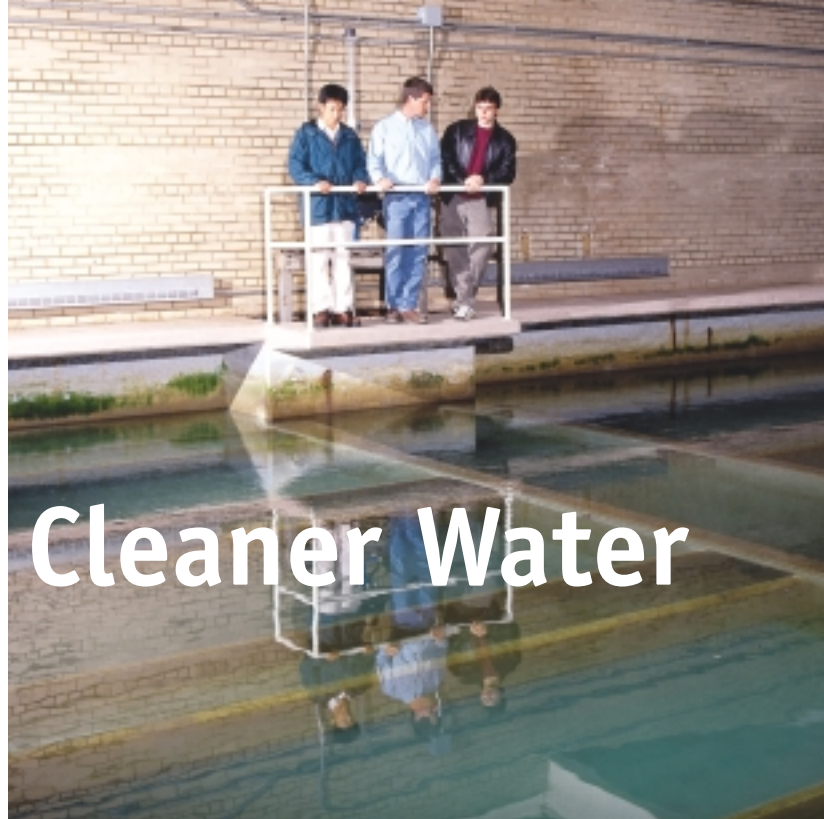
esearchers at IPRT's Center for Sustainable Environmental Technologies are developing technology to turn waste sulfur from coal combustion into a chemical used to purify water. The effort, which has its roots in China, is being assisted by two Iowa utilities.

Most coal contains sulfur, which, when released into the atmosphere as sulfur dioxide, contributes to acid rain and environmental degradation. New technologies are being developed that convert coal into a gas, which can then be chemically scrubbed to remove sulfur before the coal gas is burned.

CSET researchers believe they've found a good use for leftover sulfur that results from this process. With support from the U.S. Department of Energy's University Coal Research Grant program, CSET is collaborating with a visiting Chinese scientist, Maohong Fan, to convert that sulfur into a chemical used to purify waste water and drinking water. The University of South Carolina is partnering in the project and will adapt the technology to wastewater plant needs in the southeastern United States.

The technology Fan developed converts sulfur into polymeric ferric sulfate, or PFS, a flocculating agent that speeds settling of suspended dirt and other solids in water. His research is looking into synthesizing PFS and its applications in water treatment. PFS is anticipated to be cheaper than conventional water-treatment agents such as alum and ferric chloride. Unlike alum, it contains no aluminum, which has been implicated in the development of Alzheimer's disease.

"Industry uses large quantities of flocculating agents to clean up waste water before it is discharged to rivers, while municipal waterworks use them to clarify drinking water. The market for this kind of product is very large," said Robert Brown, CSET director and an Iowa State University professor of mechanical engineering and chemical engineering.



Maohong Fan, a visiting scientist from China (left), along with Iowa State University students Scott Schaefer and Matt Byers, examine a water basin at the Des Moines Water Works, which will provide facilities to test water-purifying technology developed by Fan.

The two Iowa utilities involved in the project are the Des Moines Water Works and Alliant Power of Cedar Rapids. DMWW will provide pilot-plant facilities for testing PFS synthesized at IPRT. Alliant Power will provide an internship for an ISU student to conduct economic and environmental analysis of the technology.

"As a water utility treating surface water, Des Moines Water Works has a general interest in any project with potential to reduce our costs to treat water and maintain or improve the quality of the finished water," said Ted Corrigan, director of water production. "If a more cost-effective method of producing ferric sulfate could be developed, Des Moines could benefit significantly."

Fan commercialized the PFS-conversion technology in China when he worked as a chemical and environmental engineer in

Beijing and applied it to the treatment of waste water and drinking water in several provinces. Brown invited Fan to visit CSET, where he explored the application of PFS to American water-treatment systems with seed funding from IPRT's Center for Advanced Technology Development.

Fan was born in China's Henan province, an agricultural region roughly the size of Iowa but with 90 million residents. His technology was identified when Brown visited Beijing as part of the Sustainable Development China project, which is sponsored by ISU's International Institute of Theoretical and Applied Physics. "We were looking for opportunities to bring ISU expertise to China, but I saw PFS as an opportunity to make technology transfer a two-way street," said Brown. ■

Lightening the *Load*

A sensor material developed at Ames Lab could be part of lighter, more fuel-efficient vehicles.

Ames Laboratory scientists have developed a new material that may steer automotive companies toward lightweight power-steering technology.

A quarter-inch-thick ring of the material could be used in an electronic torque sensor to regulate the steering power provided to a car's wheels by an electric motor. This would enable automakers to eliminate the heavy, energy-draining hydraulic system currently used in power-steering assists.

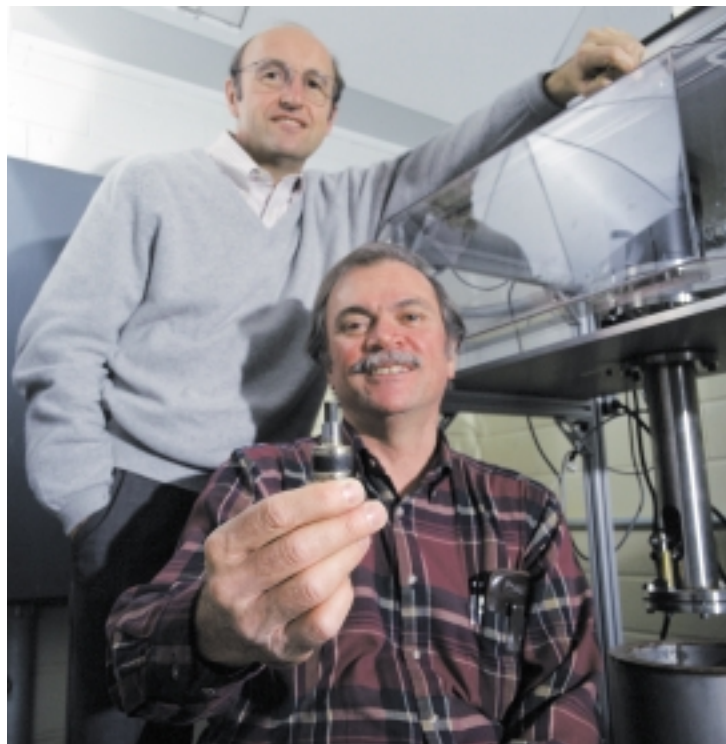
"Replacing the hydraulic power-steering system with an electrical system that uses this type of sensor should improve the fuel efficiency of a car by about 5 percent," said David Jiles, a senior physicist at Ames Lab and a professor of materials science and engineering at Iowa State University. Lighter, more energy-efficient vehicles would use less gasoline, conserving fossil fuels and reducing transportation costs, he added.

Jiles and Bill McCallum, a senior Ames Lab materials scientist and an ISU adjunct professor of materials science and engineering, looked at a number of possibilities during the past five years as they searched for an inexpensive sensor material that met the specifications of the auto industry. They say only one viable option emerged: a composite consisting of cobalt ferrite (a compound of cobalt oxide and iron oxide) and small amounts of nickel and silver to hold the material together.

"I think we've looked into all of the possibilities and it's difficult to conceive of a better material at this time," Jiles said. "The fact that it's also a relatively low-priced material makes it very attractive."

He said current power-steering systems use a hydraulic assist that requires continuous pressurization in order to sense and respond to steering changes. This produces a constant drain on the car's power, even when the steering wheel isn't being turned. "Also, the hydraulic system weighs a lot, so there's a significant weight reduction if you can replace it with an electrical system," he added.

A sensor using a small ring of the cobalt-ferrite composite would be strategically placed on the steering column. As a driver turned the wheel, the magnetization of the cobalt-ferrite ring would change in proportion to the amount of force applied by the driver. The change would be detected by a nearby field sensor that would interpret how much force should be applied to turn the wheels and then relay the information to an electrical power-assist motor. Unlike the hydraulic system, the electrical



David Jiles (standing) and Bill McCallum, both researchers at the Ames Laboratory, have developed a new sensor material that may enable automobile manufacturers to replace heavy hydraulic steering systems with lighter electric steering, resulting in fuel savings.

system would consume minimal energy when the steering wheel was not being turned.

What makes the cobalt-ferrite composite ideal for this application is a property known as magnetostriction, Jiles said. Magnetostrictive materials undergo slight length changes when magnetized. Jiles and McCallum take advantage of that property, but in reverse. In their approach, the turn of the steering wheel would apply stress to the cobalt-ferrite ring, producing a change in the magnetic field it emits.

McCallum said cobalt ferrite maintains its magnetostrictive abilities throughout the temperature range specified by the auto industry, from minus 40 F to 302 F. It also meets the strength and corrosion-resistance requirements for the sensor material. "This ceramic-metallic composite is similar in concept to materials used in high-strength tool bits where excellent mechanical properties are needed," McCallum said. "And cobalt ferrite is basically high-class rust, so it's hard to corrode any further."

Jiles said the composite is also cost-effective. While other materials may rank higher in terms of magnetostriction, they're too costly to be used in wide-scale production. For example, Terfenol-D is a rare-earth, magnetostrictive compound that Ames Lab helped develop in the 1980s. It possesses a much higher degree of magnetostriction, but can cost up to 100 times more than the cobalt-ferrite composite.

The scientists have applied for a patent on the cobalt-ferrite composite and are working with several automotive manufacturers interested in using the material in an electronic torque sensor. ■

Convincing Evidence

IPRT scientists move to fill need for forensics research center.

IIPRT and Ames Laboratory are working to provide much-needed research and casework assistance to Midwestern crime laboratories by establishing a regional forensics support and research facility at Iowa State University.

IPRT has provided seed funding for the proposed Midwest Forensics Resource Center to begin developing the partnerships needed to launch the facility, and organizers are working to identify funding sources for the center.

David Baldwin, director of Ames Lab's Environmental and Protection Sciences Program, said the forensics center would serve four main purposes.

First, it would provide the region's crime labs and law enforcement agencies with staff training needed to remain current in their fields.

Second, ISU students would have the ability to participate in a curriculum, including internships, which would make them attractive as potential employees for these laboratories. Third, it would provide crime labs with access to specialized instruments and personnel to help solve particularly difficult cases. Finally, it would be an arena for the development of new analytical techniques and tools for forensic investigators as well as providing an outlet for technologies developed locally, at Ames Lab and other IPRT centers, and nationally.

The regional aspect of the forensics center will be crucial to its success, Baldwin said. "We don't want to be a burden to any of the states in the Midwest, especially Iowa," he said. "We don't want to be a drain on resources that might otherwise go to the crime laboratories. The center needs to be a regional laboratory that's funded nationally."

Researchers have already begun laying the groundwork for the center through forensics research projects for the FBI, DOE and the Iowa Division of Criminal Investigations.

For instance, part of the IPRT seed funding helped cover the costs of adapting a glovebox to serve as an improved fingerprint-development chamber for the Iowa crime lab. The chamber



IPRT and the Ames Laboratory are working on a number of forensics projects, including analysis of bomb-blast fragments. The projects are part of an effort to establish a regional forensics support and research facility at Iowa State University.

provides greater control in detecting fingerprints from crime-scene evidence.

Carl Bessman, a criminalist with the Iowa Division of Criminal Investigations, said the assistance his crime lab has received from Ames Lab and IPRT has proven valuable. "Ultimately, applying good science to the casework is our most important responsibility," he said.

Baldwin said developing methods for analyzing crime-scene evidence is more complicated and demanding than it first appears.

"Forensic science is a matter of how well you can prove that

the items are the same or different," he said. "You're looking for matches or differences, and you have to be very good about knowing when you did it right and when you did it wrong. And you have to be able to tell a jury how certain you are. You can't make a mistake."

To find out how the proposed center could best serve crime laboratories, Baldwin and other organizers invited forensic investigators from eight Midwestern states and four federal agencies to a May workshop at ISU. The crime-lab representatives gave input on the types of research, services and training that would be most helpful to their facilities, and suggested funding sources for the proposed center.

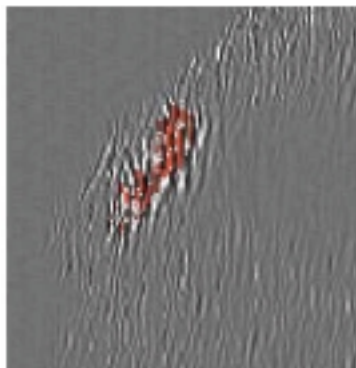
Mike Elliot, who works for the National Terrorism Preparedness Institute, attended the meeting and said, "I was very impressed by what I've seen. There is such obvious dedication at IPRT and Iowa State to this concept. Iowa State has a great deal of credibility at the national level because of its strong science and technology programs."

Several workshop participants volunteered for committees that will make recommendations for the proposed center in four main areas: development of undergraduate and graduate curricula, the types of professional training and certification to be offered, specialized analytical services that could be provided, and a "wish list" of research projects that would improve the capabilities of forensic science. ■

New Views into Surgery

The Center for Nondestructive Evaluation collaborates with the University of Iowa to improve surgical procedures.

Scientists at IPRT's Center for Nondestructive Evaluation are using their expertise and tools, such as ultrasound and X-ray, for inspecting engineered parts to break new ground in image-guided surgery. Experts from the University of Iowa's (UI) department of radiology, led by Dr. Michael Vannier, are providing advice and guiding the research to address important medical issues.



In this ultrasonic microscopy image of a heart-vessel wall, hardened plaque is highlighted in red.

Researchers at both universities are confident their work will one day improve surgical procedures. "In these projects, unique expertise developed for nondestructive evaluation of structural materials is now being applied to biomedical imaging. Because these capabilities are complementary to those currently used in medicine, they promise to enable significant improvements in imaging capabilities, making an important impact on human health," said Bruce Thompson, CNDE director. The research was funded in part by a \$600,000 gift from the Roy J. Carver Charitable Trust of Muscatine.

The scientists are developing techniques that should improve surgery success rate and recovery time without increasing the invasiveness of procedures. Four major areas are being investigated:

- X-ray contrast agents. Contrast agents, such as iodine dyes, are used to prepare for the X-ray images of blood

vessels, known as angiograms. Not only do some patients experience pain when given iodine, but iodine also lacks the sensitivity of other contrast agents that could provide more precise images of arteries. UI radiologist Dr. Brian Mullan and chemist Lou Messerle are providing input on alternative contrast agents that could be used with high-resolution X-ray techniques developed by CNDE scientist Joe Gray. By taking advantage of the fact that X-rays are absorbed at varying levels by different tissues, scientists can achieve stronger visual contrast in angiograms. Improved contrast agents should enable faster cancer diagnoses as well as other medical benefits.

- Brachytherapy. An innovative treatment for prostate cancer, brachytherapy involves planting radioactive seeds in the prostate and applying radiation to eliminate tumors. For the best results, the proper dose of radiation must be delivered to the correct location. However, properly positioning the seeds

becomes difficult when diseased tissue swells or the patient shifts position.

To overcome these challenges, CNDE researchers are developing computational techniques with data from digital radiography and ultrasound images to estimate changes to the radiation field in real time as the insertion procedure progresses. A display of the radiation field, shape of the prostate gland and distribution of radioactive seeds will make evaluation of the procedure's progress easier for medical staff. With real-time visual feedback, staff can correct steps if necessary and improve the procedure's success rate.

"These techniques are possible only through vast amounts of data acquisition and computational power with near real-time execution speeds, all developed at CNDE," said Feyzi Inanc, CNDE scientist.

- From 2-D to 3-D ultrasound. Though ultrasound images

have traditionally been two-dimensional, scientists have the capability to add a third dimension by combining multiple, two-dimensional image slices. More comprehensive ultrasonic images would provide benefits not only in prenatal care but in cancer diagnosis, study of vital organs and image-guided surgery. CNDE researcher Viren Amin is establishing an experimental system to compare raw, unprocessed ultrasound data with data from UI's state-of-the-art digital ultrasound scanner. One application of advanced ultrasound imaging would be improved brachytherapy procedures. With enhanced imaging capabilities, doctors could place radioactive seeds in ideal locations for treating prostate cancer.

- Intravascular ultrasound imaging. Heart disease is identified by plaques of cholesterol and other build-up in blood vessels of the heart. By merging CNDE's expertise in ultrasonic signal analysis and UI's expertise in plaque physiology, Amin and CNDE's Ron Roberts, with guidance from UI's Dr. Steve Lentz and engineer Milan Sonka, are measuring the difference in how healthy and diseased tissues scatter waves. Real-time, cross-sectional ultrasound images of heart vessel walls may improve disease treatments by identifying differences in density and elasticity in healthy and diseased tissue. ■

"Fast-talking" Clusters

The Center for Physical & Computational Mathematics gets a grant to explore ways of speeding communication in cluster computers.

The National Science Foundation has awarded a Major Research Instrument grant to IPRT's Center for Physical and Computational Mathematics. The MRI grant is for \$300,000, including \$190,000 from NSF and more than \$100,000 in matching funds from IPRT and the Iowa State University departments of chemistry and physics. CPCM researchers will use the MRI funds to improve communication technology in cluster computers – personal computer or workstation networks that can operate at speeds comparable to today's commercial parallel computers, but for a fraction of the cost.

"Users are beginning to see clusters as a good thing," says Mark Gordon, an ISU distinguished professor of chemistry and a principal investigator in the MRI effort. "A university department or a research group can't afford to buy a supercomputer, but they can afford to put a good cluster together. So the issue now is how do we help those people maximize cluster efficiency?"

CPCM researchers will take advantage of the expertise and facilities available at the Scalable Computing Lab of the Ames Laboratory to investigate interconnect solutions for cluster computers. Making message-passing between computers in a cluster faster and more efficient is the primary goal of the MRI-supported research effort.

Gordon emphasizes that solutions to grand-challenge problems, such as the design of new materials and catalysts, the development of viable methods for

environmental remediation, and the search for the origin of life, will depend on state-of-the-art computational hardware and applications software to take advantage of modern computers. "The high-performance computing environment of the future will undoubtedly include scalable cluster computing," he says. (Scalability refers to the ability to increase, or "scale up," computer processing power to run the same job in less time.)

"In the case of clusters, we want to figure out how to best manage the hardware and get computers talking to each other with a minimum amount of time used in communicating and a maximum amount of time in actually doing the calculations," Gordon continues. "That's what the MRI grant is all about."

Communication in cluster computers is governed by the switch that sends information from one computer to another in a cluster. The Scalable Computing Lab has a Gigabit Ethernet switch that directs messages to a cluster of 22 IBM dual-

processor Power 3 systems. (Each system, or node, has two central processing units for a total of 44 CPUs.) It is this IBM cluster and the Gigabit Ethernet switch governing it that CPCM researchers will use to optimize internode communications.

"The Gigabit Ethernet switch is supposed to send one gigabyte, or a thousand megabits, of information per second from node to node in a cluster," says Gordon. "But it only works at about 30 percent efficiency." He notes that Brett Bode, a co-principal investigator on the MRI grant, discovered that as the number of bytes of information being sent per second is increased, efficiency goes up from 30 percent to 80 percent. "That's the good news," says Gordon. "The bad news is that few companies, if any, are making switches that allow you to send sufficiently large amounts of information. Switch technology is really in its infancy. Companies are not designing switches that are made to do real science."

In an effort to remedy the situation, CPCM researchers are already investigating ways to optimize communication throughput with the Gigabit Ethernet switch as well as with alternative switch technologies.

"CPU power doubles about every 18 months, while communication speed doubles only every three years," says Gordon. "So it's clear that the true bottleneck in advancing cluster computing lies in the communications." ■



This Gigabit Ethernet switch sends information from one computer to another in a cluster computer.

SCIENCE AND TECHNOLOGY Education



Charles Stewart Jr. graduated from Iowa State University in May 2000 with a degree in agricultural biochemistry. A great achievement, but one made more remarkable by the fact that Stewart became the first ISU graduate from Science Bound, an IPRT-run program aimed at increasing the number of underrepresented students of color in science and technology careers. This program is only one of many ways that IPRT enriches science and technology education in Iowa.

EDUCATION

Science Bowl

The Ames Laboratory/ISU 2000 Science Bowl proved to be the biggest ever. The event consists of teams from Iowa high schools in a fast-paced, daylong competition to answer a broad range of science and math questions.

A record 47 teams, each with up to five students, competed in

the event. The competition was opened to more teams in 2000 as an increasing number of schools expressed interest in the event. Approximately 90 faculty and staff members from Ames Laboratory, IPRT and ISU served as moderators, judges, timekeepers and scorekeepers.

The event is one of more than 60 regional Department of Energy competitions throughout the nation. First developed in 1991, the goal of Science Bowl competition is to encourage high school students to excel in science and math and to pursue careers in those fields. The Ames Laboratory/ISU Science Bowl is one of only seven in the nation to be held all ten years of the event.

Ames High School won the 2000 edition of the competition, marking the school's fourth title in the 10-year history of the event. Central Academy of Des Moines took second place, while Cedar Falls High School took third. Ames High advanced to the DOE's National Science Bowl in Chevy Chase, Md. ■



High school students from around Iowa compete in the Ames Laboratory/ISU Science Bowl.

SCIENCE BOUND

Reaches New

Science Bound, whose mission is to increase the number of underrepresented students of color pursuing technical careers, has marked several milestones in the last year. The innovative IPRT-managed program was created with the Des Moines Public Schools. It involves 8th-12th grade students, their parents, math and science teachers, ISU professors and volunteers. Students who successfully complete the program and pursue a technical degree at ISU receive a full-tuition scholarship.

As of fall 2000, there were 41 graduates of the Science Bound program enrolled at ISU, and 38 of those students were still in qualifying degree programs. At the Des Moines Public Schools, over 200 students are participating in Science Bound this year.

Recent Science Bound highlights:

- Charles Stewart Jr. became the first Science Bound student to graduate from Iowa State University. Stewart became involved in Science Bound in the 8th grade. During his time at ISU, Stewart also served as the national president of Minorities in Agriculture, Natural Resources and Related Sciences. Stewart, who obtained his degree in agricultural biochemistry, is now in graduate school at Cornell University.



PIPELINES, a new program affiliated with IPRT's Science Bound, is a joint effort between Iowa State University and Southern University and A&M College, Baton Rouge, La., to further the technical and scientific education of underrepresented students of color.

Educating Iowa's Workforce

Heights



- Science Bound celebrated its tenth anniversary. "Ten years of teamwork by students, their parents, teachers, ISU professors and generous volunteers and sponsors has allowed Science Bound to achieve its goal of increasing students' interest and participation in science and math," said Kathy Trahanovsky, Science Bound program director.

- A new program has joined Science Bound to further its reach. Funded by NASA, the Program to Increase the Pursuit of Education and Learning In Engineering and Science, PIPELINES, is a partnership between ISU and Southern University and A&M College in Baton Rouge, La. This extension to Science Bound provides educational programs in science and math for high school students in Des Moines and Baton Rouge as well as research opportunities for college students at ISU and Southern University. ■

Chris Clover, MechDyne Corp., Marshalltown

While working on his undergraduate and graduate degrees in engineering as well as his MBA at Iowa State University, Marshalltown-native Chris Clover did research with IPRT's Virtual Reality Applications Center. All of this education and experience helped make Clover an expert in the nascent field of virtual reality and visualization.

Instead of moving to one of the world's high-tech meccas, however, Clover is building his own in Marshalltown, Iowa. Clover is the CEO of a high-tech company he helped found. MechDyne Corp. designs, installs and services virtual reality systems ranging from desk-sized systems to theater-sized facilities. These simulation environments aren't built for fun and games, however. MechDyne's goal is nothing less than to make large-scale visualization a tool routinely used by industry, said Clover. Indeed, among its many projects around the world was helping in the design and construction of VRAC's new C6 virtual reality theater.

The other three principals of the company are native Iowans and graduates of ISU. Many of its 25 employees are ISU grads as well. "Most of our employees would not be living and working in Iowa if it weren't for MechDyne. We offer exciting challenges at the high end of high tech with opportunities to see the world as well as to make the world work better," said Clover. ■

Matt Brown, Viking Pump, Cedar Falls

Matt Brown, a 1999 graduate of Iowa State University, was a sophomore studying metallurgical engineering when one of his metallurgy professors, Dr. Frank Kayser, suggested that he apply for work at the Ames Laboratory. Matt was hired by Larry Jones in the Materials Preparation Center. The job turned out to be the ideal complement to his classroom education.

Matt is now the process metallurgist at Viking Pump in Cedar Falls, Iowa. He says his work in the MPC extended his education to include a lot of direct contact with materials and processes that he wouldn't have had otherwise.

"While working in the powder metallurgy group, I did a lot of testing and sample preparation. I also gained hands-on experience with several material fabrication processes," he said.

In his position at Viking Pump, Matt ensures that all castings meet chemical and mechanical specifications. He also does failure analysis and material selection. In addition, he supervises two testing laboratories and three lab technicians. Learning to work in teams with people of various backgrounds is another aspect of his Ames Lab experience that has been a real advantage in his professional career, Matt says.

Viking Pump, Inc., a unit of the IDEX Corporation, is a leading manufacturer of positive displacement pumps. Viking Pump manufactures positive-displacement pumps and flow-control systems for a variety of fluid-handling applications. With about 750 employees, Viking Pump is Cedar Falls' largest private employer. ■



MechDyne CEO Chris Clover (bottom right), experiences virtual reality with fellow founders Mike Hancock (bottom left), Kurt Hoffmeister (top left) and Jim Gruening (top right).

Photo By Bob Nandell, copyright 1999 The Des Moines Register and Tribune Company. Reprinted with permission.

■ MPC Takes Process Initiative

An effort is underway at the Materials Preparation Center to delve more deeply into the mysteries of processing science — the methods by which metals and alloys are synthesized in order to give them specific properties. By turning the MPC into a test kitchen of sorts, its scientists hope to better understand existing processing methods and develop “recipes” for making advanced materials for future technologies.

A new program called the Process Science Initiative offers a limited pool of competitive funding for two types of materials-processing projects: those that lead to an improved understanding of existing processing techniques and those that explore new techniques for producing novel materials.

Brian Gleeson, an assistant professor of materials science and engineering at Iowa State University, serves as PSI program manager. He said it’s critical that scientists understand what happens to a material when it goes from a liquid state to a solid state because most metals and alloys are made of tiny crystals. The way in which the liquid crystallizes to form the microstructure of the solid determines the material’s properties, such as its strength and pliability.

The U.S. Department of Energy provides the funds for the PSI program, while the MPC provides the research facilities. MPC is an IPRT center and a designated DOE user facility that specializes in preparing small samples of high-purity, novel materials not available from commercial sources. ■



Ames Lab scientist Matt Kramer displays tinsel-like ribbons produced through melt spinning, the byproduct of an effort to explore the rapid solidification of metals.

The C6 virtual reality theater, built by the Virtual Reality Applications Center, is being used to explore technology that will allow engineers from remote locations to work together in the same “virtual” space.



■ VRAC Unveils Virtual Reality Theater

The Virtual Reality Applications Center opened its C6 virtual reality theater in June 2000. The system is one of the first virtual reality systems to immerse users with computer-generated images on all four walls, ceiling and floor. Its wireless interaction devices are also unique, giving users an unprecedented level of freedom inside the system.

The C6 is a three-story high facility located in the atrium of Iowa State University’s Howe Hall. Inside sits a 10-ft. cube room. High-resolution projectors beam computer-generated images onto screens that make up the walls and ceiling of the room. A 2,000-lb., 2-3/4-inch thick piece of Plexiglas allows images from the bottom projector to appear on the floor of the C6. Through the use of special eyeglasses, the images appear in 3D to users. The wireless devices track users’ movement, allowing them to essentially “walk” through the virtual environments generated by special software on a bank of high-powered computers.

“C6 will provide a space where real engineering can be accomplished in a virtual environment,” said Jim Bernard, VRAC director and distinguished professor of mechanical engineering at ISU. Bernard, along with Carolina Cruz-Neira, associate VRAC director and Litton assistant professor of electrical and computer engineering, and other VRAC researchers designed and implemented the system in cooperation with MechDyne Corp. of Marshalltown, Iowa.

VRAC’s new facilities are also helping it push the envelope of virtual collaboration, in which teams of people can work together in virtual environments located any distance apart.

A new multimedia auditorium in Howe Hall is part of this effort. It can display 3D images from both the C6 and the C2, VRAC’s other virtual reality theater, simultaneously, allowing a group of up to 250 people to share the experience of users inside the virtual reality systems.

The C6 was funded by Iowa State University, IPRT, ISU College of Engineering and numerous industrial and government sponsors. ■

■ **New Lab to Study Magnetoelectronics**

Scientists at Ames Laboratory and Iowa State University are working to establish a new magnetoelectronics laboratory. The rapidly growing field of magnetoelectronics combines microelectronics and magnetics; one application is to create new technologies that will quench the public's growing thirst for greater data-storage capacities on computers.

"Magnetoelectronics is a very, very hot area. We've all got computers and we all want to be able to store more and more data on them," said David Jiles, a senior physicist at Ames Lab and ISU professor of both materials science and engineering and electrical and computer engineering. "Ames Laboratory and Iowa State need to get into this area because there's a huge market for this type of cutting-edge technology."

Much of the work in the new lab will involve using an ion-beam deposition system to produce materials in the form of thin films for technologies that will expand computer data-storage capacities. Many personal computers available today have disks capable of storing 10 gigabits of information per square inch. Creating higher-density disks that could store 100-500 gigabits of information per square inch will require condensing the data into smaller bits. This, in turn, will trigger the need for smaller "read-heads" to read the data. "You can't simply shrink down the existing read-head technology because it won't work," Jiles said. "Other technologies have to be brought in."

The lab was made possible by a \$530,000 grant from the Roy J. Carver Charitable Trust of Muscatine. ■

■ **CSET Works to Reduce Pollution**

The Center for Sustainable Environmental Technologies is collaborating with Energy Systems Associates of Pittsburgh to explore a new method for reducing nitrogen oxide emissions from coal-fired utility boilers by using agricultural crops and residues. The emission, commonly known as NO_x, is a precursor to acid rain and creates smog in large cities.

The project combines CSET's expertise in biomass energy with ESA's experience in advanced pollution-control technology. The researchers propose to inject a mixture of water and plant material such as cornstover (leftover corn stalks and leaves), switchgrass and alfalfa above the fireball in coal-fired boilers. The material, called biomass, decomposes almost instantly at high temperatures in the boiler to produce a gas. When this biomass-derived gas combines with burning coal gas, it promotes chemical reactions that break down 40 percent to 60 percent of the NO_x emissions into harmless nitrogen gas.

The project is led by Robert C. Brown, CSET director and an ISU professor of mechanical engineering and chemical engineering, and Bernard Breen, president of ESA. They received \$150,000 from the U.S. Department of Energy's National Energy Technology Lab and \$70,000 in cost-sharing support from ESA and ISU to conduct this research. ■

■ **CNDE Research to Improve Railway Inspection**

The Center for Nondestructive Evaluation has received a gift of equipment and financial support from the Krautkramer company, a producer of phased-array ultrasound equipment. The equipment will enable CNDE associate scientist Dave Utrata to expand techniques for detecting and characterizing flaws in railroad rails.

CNDE's proposal to use the equipment on railroad rails is practical because rails are vulnerable to wear and damage after long periods of use and heavy loads. A well-trafficked stretch of rail carrying heavy loads can suffer from internal fatigue cracking. These flaws in steel rails, if not detected, can lead to derailment and catastrophic accidents. In addition to safety, rail inspection offers economic benefits by making it possible to identify flawed areas, cut them out and replace them, rather than replacing miles of rail.

The benefits of the phased-array system include the ability to steer the ultrasonic probe, rather than using beams that target fixed places. "Conventional fixed probes don't offer the same

range of positions for studying rail. The new phased-array system could give us beams of ultrasound that sweep through the rail, providing a new perspective on flaws in a more sensitive and efficient manner," Utrata said.



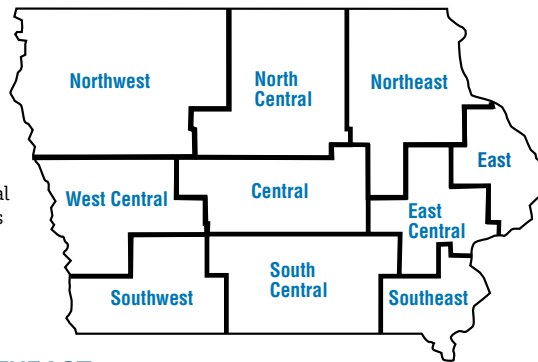
The Center for Nondestructive Evaluation has received an award to develop new techniques to evaluate railroad rails.

and an ultrasonic array probe. ISU was one of several schools to enter the company's equipment competition and received the award for proposing the most relevant and practical industrial application. An additional \$16,000 to support research and related costs of using the equipment was also received. ■

Iowa Interactions

FY 1999–2000

The Institute for Physical Research and Technology assisted over 180 organizations in 52 Iowa counties. This assistance ranges from initial contact and referral to full research projects. This listing is incomplete as many companies request that their contact remain confidential.



NORTHWEST

George

Sudenga Industries, Inc.
Humboldt
Hadar Manufacturing, Inc.
Ida Grove
GOMACO

Laurens

Positech
Milford
Cycle Country Accessories
Sergeant Bluff
Kind & Knox Gelatine, Inc.
Sioux Center
VBS, Inc.

Sioux City

Schaeff, Inc.
Spirit Lake
Tri States Grain Conditioning
Storm Lake
Merrill Manufacturing Co.
Nature's Furnace, Inc.
Thor
Fischer Enterprises

NORTH CENTRAL

Blairsburg

Chamness Technology, Inc.
Charles City
Salisbury Chemicals

Clarion

Hagie Manufacturing Co.

Clear Lake

Technology Labs, Inc.

Conrad

Ritchie Industries

Dayton

DeKalb

Eagle Grove

M & M Livestock Products Co.

Forest City

Innovative Retail Solutions
Ron Holland House Moving
Winnebago Industries, Inc.

Fort Dodge

Celotex Corp.
Iowa National Guard
Josephson Manufacturing Co.
United States Gypsum Co.

Garner

Iowa Mold Tooling Co.

Hampton

Seabee Corp.
Seabee Foundry

Hubbard

City of Hubbard

Jewell

Arko Laboratories Ltd., Inc.

Klemme

BMD Co., Inc.

Mason City

IMI Cornelius, Inc.

Sheffield

Sukup Manufacturing Co.

Webster City

Frigidaire Co. Laundry Products
Land O' Lakes
Swine Graphics Enterprises

NORTHEAST

Cedar Falls

Iowa Laser Technology, Inc.
Viking Pump, Inc.
Decorah
Deco Products Co.
Oelwein
Heartland Resource Technologies, Inc.
Postville
Industrial Laminates/Norplex, Inc.
Waterloo
Deere & Co. Waterloo
OMJC Signal, Inc.

WEST CENTRAL

Carroll

Delavan-Carroll, Inc.

Harlan

BioMass Agri-Products, L.L.C.
Jacobs Corp.

Ralston

West Central Cooperative

Templeton

Paq-Cell, Inc.

CENTRAL

Adel

Thermal Dynamics

Albion

DONCO Air Products

Ames

3M Corp.
8VA Corp.
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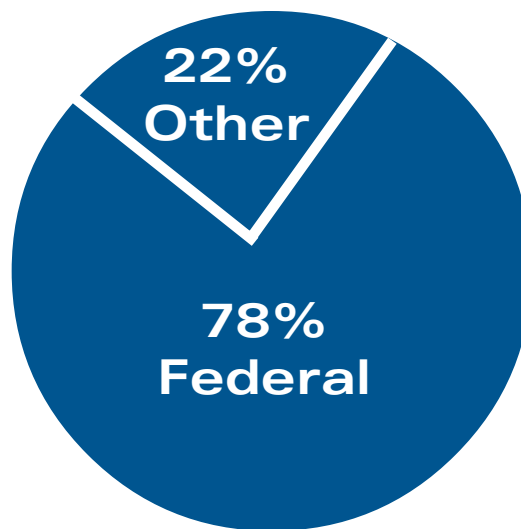
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